Escape and Capture from Deep Gravity Wells (Earth, Moon, Planets) Using Low Thrust Propulsion Systems

Completed Technology Project (2015 - 2016)

Project Introduction

NASA missions are increasingly looking to use low thrust propulsion to capture into planetary orbits and/or lunar orbits, and to escape from low earth orbit. This problem is one of the most challenging in mission design and the ability to design and optimize orbits of this class is an enabling technology for missions planning to employ low thrust deep capture and enhancing technology for missions that require optimal solutions that make the best use of limited expendable resources. Under this effort, we will leverage work performed to support "low-rev" low thrust mission to develop a robust capability to support "many-rev" mission designs for Earth, Lunar, and Planetary missions.

Low thrust is an enabling technology for a large class of missions and has been employed by SMART-1, HAYABUSA and Dawn. To date, no mission has employed low thrust to escape from deep within a large gravitational body's gravity well, or to capture deep into a gravity well. For example, SMART-1 started in a GEO synchronous transfer orbit, and captured into a highly eccentric lunar orbit. Applications of this nature result in many hundreds or even thousands of revolutions and are called the "many-rev" problem in the literature. This effort will develop robust techniques for designing optimal trajectories in the many-rev regime for earth, lunar, and interplanetary missions.

Anticipated Benefits

Enable NASA missions that must employ low-thrust to escape or capture in deep gravity well. Reduce risk for cube sat missions and missions in proposal phases that require mid-level TRL technology.

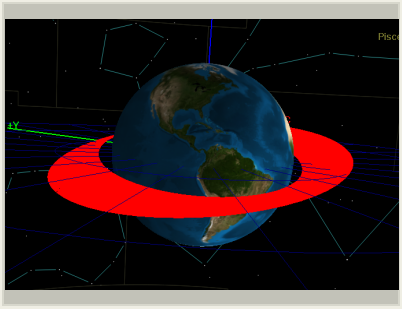


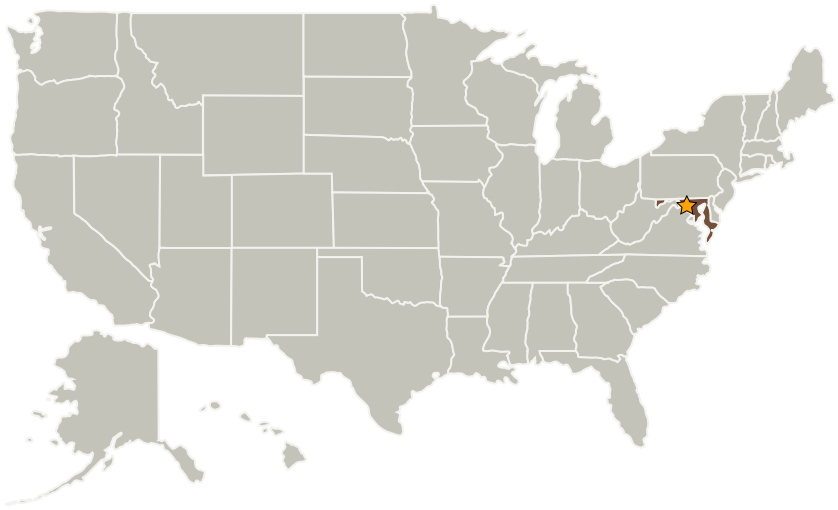
Image of Low Thrust Spiral Trajectory

Table of Contents

Escape and Capture from Deep Gravity Wells (Earth, Moon, Planets) Using Low Thrust Propulsion Systems

Completed Technology Project (2015 - 2016)

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations
Maryland

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Center Independent Research & Development: GSFC IRAD

Project Management

Program Manager:

Peter M Hughes

Project Manager:

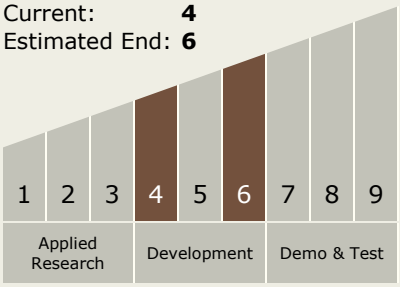
Dennis W Woodfork

Principal Investigator:

Steven P Hughes

Technology Maturity (TRL)

Start: **4**
Current: **4**
Estimated End: **6**



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Images

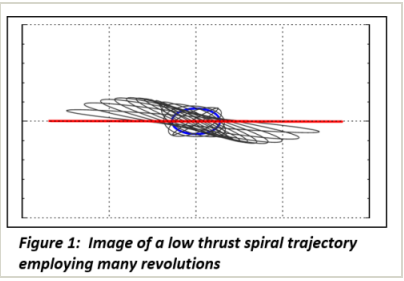
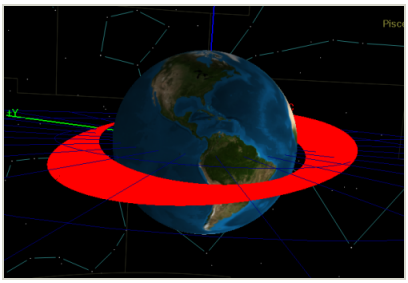


Figure 1: Image of a low thrust spiral trajectory employing many revolutions

Image of a low thrust spiral trajectory employing many revolutions
Image of a low thrust spiral trajectory employing many revolutions
(https://techport.nasa.gov/image/19090)



Spiral Trajectory Image
Image of Low Thrust Spiral Trajectory
(https://techport.nasa.gov/image/19138)

Project Website:

http://aetd.gsfc.nasa.gov/

Technology Areas

Primary:

- TX11 Software, Modeling, Simulation, and Information Processing
  - TX11.5 Mission Architecture, Systems Analysis and Concept Development
    - TX11.5.2 Tools and Methodologies for Performing Systems Analysis